Time to Adopt New Measures of Severe Obesity in Children and Adolescents

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The ideal measure of weight gain and loss should distinguish children and adolescents across the distribution of weight and height and should include the capacity for changes in weight adjusted for height over time. Over short intervals, in which there is little growth in height, absolute changes in weight or BMI provide suitable indicators of weight gain or loss. However, over longer intervals, during which height increases significantly, weight change must be adjusted for changes in height and age by sex. BMI, which is calculated as weight (in kg) divided by the square of height (in m²), adjusts body weight for height. Although the correlation of BMI with various measures of body fat percentage is modest across the distribution of BMI, the correlation of BMI with body fat improves at the upper part of the body fat distribution. Increases in BMI greater than the 95th percentile are associated with increases in body fat.1,2 In addition, BMI has benefits in feasibility, reliability, and measurement and clinical validity.3

Changes in BMI, BMI percentiles, or changes in BMI expressed as an SD score (BMI z score [BMIz]) provide a reasonably accurate reflection of weight gain or loss for children and adolescents whose BMI percentile is between the 3rd and 97th percentiles of the 2000 Centers for Disease Control and Prevention (CDC) BMI growth charts because BMIzs were developed from the data used to construct these percentiles.4 However, the extrapolation of z scores or the use of percentiles to assess severe obesity is problematic because large changes in weight and BMI are associated with small changes in BMIz or BMI percentiles. The explanation for why this is the case is beyond the scope of this editorial, but details can be found elsewhere.5,6

It is now apparent that the use of z scores for the assessment and tracking of severe obesity should no longer be used. The most recent salvo was fired by Freedman and Berenson7 in this issue of Pediatrics. The authors examined the longitudinal tracking of the following 3 BMI metrics in children with severe obesity examined longitudinally in the Bogalusa Heart Study: BMIz, BMI as a percent of the 95th percentile (BMIp95), and BMI minus BMI at the 95th percentile (ΔBMIp95), for age and sex. Severe obesity was defined as BMI ≥120% of the 95th percentile for age and sex. Correlations of BMIz over time were significantly weaker than those for BMIp95 or ΔBMIp95, particularly for younger children. Paradoxically, BMIzs decreased in several children who increased their BMIs ≥5 BMI units over the examination periods.

This article joins several others in which authors demonstrate the weakness of the BMIz as a measure used to track obesity. Freedman et al,8 which includes several authors from the CDC, recently showed that BMIp95 and ΔBMIp95 were only moderately correlated with BMIz in an analysis of >150,000 2- to 4-year-old children with severe obesity. Freedman et al9 also showed that BMIz was poorly correlated with a variety of measures of adiposity, whereas correlations of BMIp95 and ΔBMIp95 with the same...
measures of adiposity had ranges of \( r = 0.32–0.79 \).

With these publications, Freedman et al.\(^7\)–\(^9\) have provided substantial support for the elimination of the BMIz as a measure of severe obesity or for measuring changes in severe obesity. Their data support a robust chorus that has pointed out the same weaknesses. Chorus members include authors from the CDC who developed the CDC growth charts,\(^8\)–\(^10\) the chair of the nutrition committee of the American Academy of Pediatrics,\(^11\) authors of the American Heart Association’s publication on severe obesity,\(^12\) and the lead developer of the International Obesity Task Force growth charts.\(^13\)\(^14\)

The widespread agreement that alternatives to the BMIz should be used to assess changes in severe obesity leaves unresolved which measures should be used and how to establish the appropriate metric. Suitable alternatives to the BMIz to measure severe obesity include absolute BMI, BMI\(_{p95}\), \( \Delta \)BMI\(_{p95}\), or BMI as a percentage of the median BMI for age and sex. The advantage of all these measures is that they provide a clear separation among children and adolescents with severe obesity. Furthermore, these measures provide quantifiable increases and decreases in BMI for a single patient and for comparison of changes with other children or adolescents over time. As required, Freedman and his CDC coauthors include their disclaimer that “the findings and conclusions in this report are those of the authors and not necessarily those of the Centers for Disease Control and Prevention.”\(^7\) Nonetheless, because the CDC developed the BMI growth charts, terminology, and cut-points for overweight and obesity and have demonstrated the utility of the BMI\(_{p95}\) and \( \Delta \)BMI\(_{p95}\) for changes in severe obesity, the CDC is the appropriate authority to identify and disseminate the appropriate metrics for severe obesity. In fact, its publications have already done so.

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**ABBREVIATIONS**

| ΔBMI\(_{p95}\) | BMI minus BMI at the 95th percentile |
| BMIp95 | BMI as a percent of the 95th percentile |
| BMIZ | BMI z score |
| CDC | Centers for Disease Control and Prevention |

**REFERENCES**


11. Kelly AS, Daniels SR. Rethinking the use of body mass index z-score in children and adolescents with severe obesity: time to kick it to the curb? [published online ahead of print June 7, 2017]. *J Pediatr*: doi:10.1016/j.jpeds.2017.05.003


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